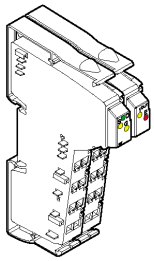


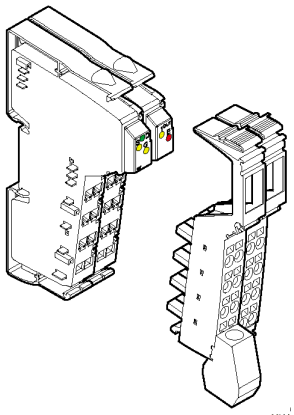
VersaPoint I/O Module

High-Speed Counter 24VDC Module
IC220MDD840

GFK-2052 *February 2004*

Module IC220MDD840 is a High-speed Counter module that reads and processes fast pulse trains from 5VDC or 24VDC input sensors. Electronic sensors are recommended. The module has four operating modes: frequency measurement, event counting, time measurement, and pulse generation.

Module MDD840 has a counter input, a control input, and a configurable switching output that provides up to 500mA of current. It can provide quick response times independent of the control system.



Module with I/O Terminal Strip

Module IC220MDD840 requires one (1) I/O Terminal Strip, IC220TBK203 or two IC220TBK082, ordered separately. See the ordering information below.

Features

- Conditional event counting
- Time measurement
- Time- or state-driven frequency measuring
- Pulse generating from 1kHz to 10kHz
- Counting starts automatically
- Selectable source and gate input combination
- Supports RC filter on inputs
- Support start and stop value changes on the fly

Ordering Information

IC220MDD840	High-speed Counter 1 In / 1 Out 24VDC
IC220TBK203	Terminal Strip Set Counter/Analog required for 5V inputs
IC220TBK082	I/O Terminal Strip, unshielded, quantity 10, can be used for 24V inputs

Module Specifications

Housing dimensions (width x height x depth)	24.4mm x 120mm x 71.5mm (0.96in. x 4.8in. x 2.86in.)
Connection style	5V sensors: 2-wire + shield
	24V sensors: 2-wire and 3-wire
	Actuators: 2-wire technology
Cable connections	Spring-clamp terminals
Conductor cross-section	$0.2mm^2$ - $1.5mm^2$ (24-16 AWG)
Operating temperature	-25°C to +55°C, (-13°F to +131°F)
Storage temperature	-25°C to +85°C (-13°F to +185°F)
Operating humidity	75% average, 85% occasionally, non-condensing. Take appropriate measures against increased humidity.
Storage humidity	75% average, 85% occasionally, non-condensing.
Degree of protection	IP 20 according to IEC 60529, DIN 40050
Class of protection	Class 3 according to VDE 0106, IEC 60536, DIN 57106-1

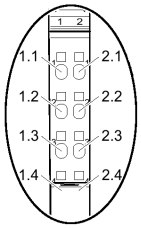
Power Consumption

24V Power Supply	19.2 to 30VDC including ripple
Communications power U_L	7.5V
Current consumption from local bus U_L	40mA typical, 50mA maximum
Power consumption from local bus U_L	0.375W maximum
Segment supply voltage U_S	24VDC (nominal)
Nominal current consumption at U_S	1A maximum

GFK-2052 *February 2004*

Installation Instructions

Connections

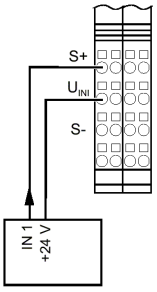


5V sensors and actuator are connected to the module via connector set IC220TBK203. This connector set provides a shield connector and a standard connector. The shield connector must be used for 5V signals. Please refer to the detailed cable connection instructions in your NIU User Manual.

For 24V signals, the cables do not need to be shielded and two standard connectors IC220TBK082 can be used instead of connector set IC220TBK203.

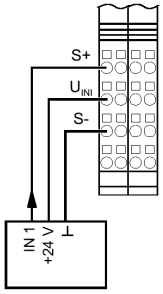
Connection Examples

24V Sensor, 2-Wire



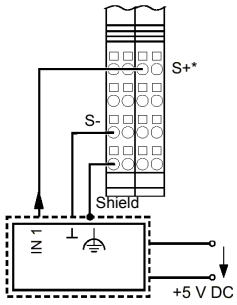
The sensor signal is routed to the S+ terminal. The sensor receives power by the voltage U_{INI}.

24V Sensor, 3-Wire



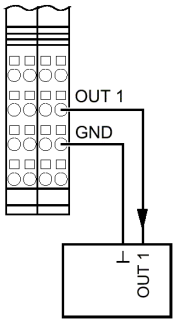
The sensor signal is routed to the S+ terminal. The sensor receives power from U_{INI} and S- terminals.

5V Sensor



For a 5V sensor, the sensor signal is routed to the S+* terminal. The S- terminal forms the reference ground. The sensor is grounded to FE via the shield connector. The 5V supply for the sensor must be provided externally.

Actuator

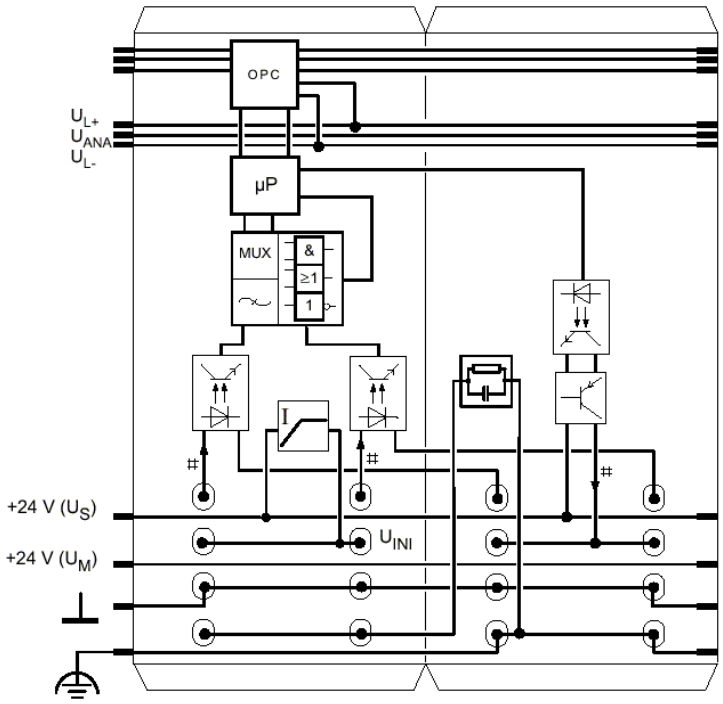


Actuator power is provided through output OUT1. The load is switched directly by the output. Do NOT exceed the 500mA current rating of the output. Excessive current will cause the output to switch off.

Terminal	*Signal*	*Assignment*
Connector A		
1.1	S+	24V counter input (source)
2.1	G+	24V control input (gate)
1.2	U_{INI}	+24V sensor voltage (source)
2.2	U_{INI}	+24V sensor voltage (gate)
1.3	S-	Reference ground for the counter input (source), sensor and segment voltage (to GND)
2.3	G-	Reference ground for the control input (gate), sensor and segment voltage (to GND)
1.4, 2.4	Shield	Shield connection (high resistance and capacitance to FE)
Connector B		
1.1	S+ *	5V counter input (source)
2.1	G+ *	5V control input (gate)
1.2, 2.2	Out	Output, terminal points jumpered internally
1.3, 2.3	GND	Reference ground for the output, terminal points jumpered internally
1.4, 2.4	FE	Functional earth ground (to FE)
The short-circuit protected sensor voltage U_{INI} is generated from the segment voltage U_S. The main voltage U_M is not used at the counter terminal points.		

LED, Color	*Meaning*
D Green	*Bus diagnostics*
	On: Bus active
	Flashing 0.5Hz (slow): Communications power present, bus not active
	Flashing 2Hz (med): Communications power present, bus active, I/O error
	Flashing 4Hz (fast): Communications power present, module to the left of this module has failed. Modules to the right are not configured
	Off: Communications power not present, bus not active
E *Red*	*Sensor supply short circuit*
	On: Connector 1 short-circuited between terminals 1.2 and 1.3 or between 2.2 and 2.3
	Off: No malfunction
S	Counter input status (source)
G	Control input status (gate)
1	Output status
Yellow	On: Set, Off: Not set

Internal Circuit Diagram



U_{L+}	Communications power
U_{L-}	Communications power ground
U_{ANA}	I/O supply for analog terminals
U_{INI}	+24V sensor voltage from main voltage
U_S	+24V segment voltage
	Protocol chip (bus logic including voltage conditioning)
	Microprocessor
	Optocoupler
	Digital input
	Digital output
	Transistor (output driver)
	Coupling network
	Module with multiplexer filter and logic
	Sensor supply with short-circuit protection
	Ground
	Function earth ground
	Terminal point
	Voltage or data line

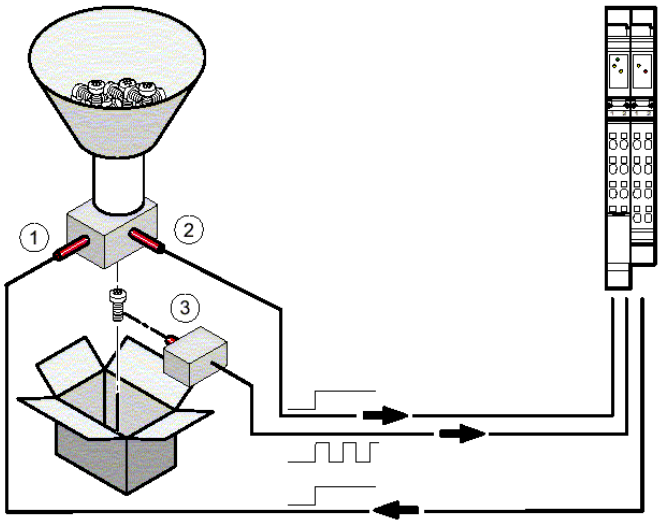
Typical Module Applications

Some typical applications for the High-speed Counter module are described below.

Event Counting

The example illustrated below shows an Event Counting application, in which sets of 100 screws are packed in a cardboard box. The control input (2) enables the count at the counter input (3) when there are screws present in the hopper. Each screw that falls out of the hopper into the box initiates a pulse at the counter input. When there are 100 screws in the box, the switching output (1) is set and the valve triggers the flap that closes the hopper. A new box can now be filled.

Number	*Sensor / Actuator*	*Associated Input / Output*
1	Valve (flap control)	Switching output
2	Sensor (control signal)	Control input (gate)
3	Sensor (counting pulse)	Counter input (source)



Frequency Measurement

Frequency measurement can be used in applications that measure speeds.

Time Measurement

The module's time measurement feature can be used for many types of applications, such as:

- Calculating the size of a part. On a conveyor belt, differences in size can be detected through differences in time.
- Measuring speed to determine if the time falls outside a specified range. For example, the output can be set at a specified maximum speed. Lower speeds can be measured in time measurement mode (which uses 16-bit values), rather than in frequency measurement mode (which uses 24-bit measured values).

Pulse Generation

The module's pulse generation feature can be used to produce and output pulse trains with frequencies in the range of 1kHz to 10kHz modulo 500Hz.

Programming Data

ID code	BF hex (191 decimal)
Length code	02 hex
Input address area	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes

Data should always be consistent over 2 words (4 bytes) to assure accuracy.

Process Data

The High-speed Counter module is configured, controlled, and read using the process data it exchanges with the NIU.

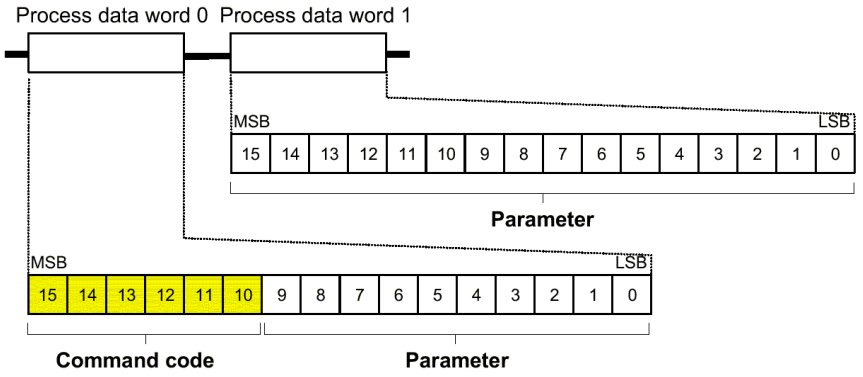
Process data for the High-speed Counter module consists of:

- Two words (four bytes) of output data that can be used to configure the module and to control the module's output.
- Two words (four bytes) of input data that reflect the present states of the module's inputs.

The format of the process data is shown below and on the next page. Detailed descriptions of data formats are on the following pages.

Process Data: the Output Words

The NIU sends the High-speed Counter two words of output data. This data can be used to configure and control the module. The basic format of this data is:

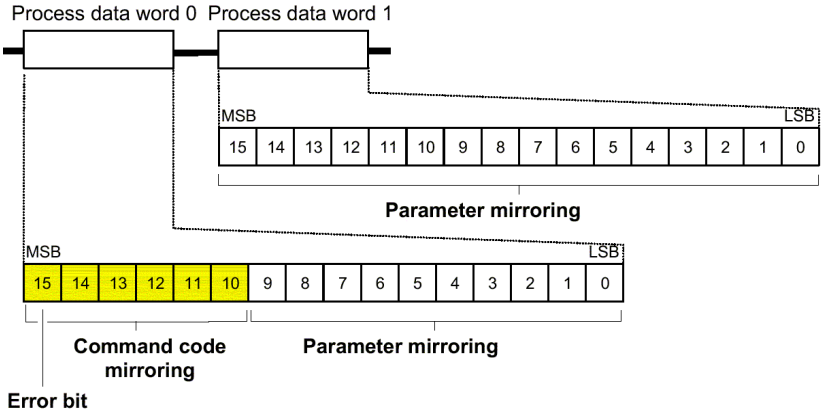

Process data word 0
Process data word 1
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Parameter
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Command code
Parameter

Process Data: the Input Word

In return, the High-speed Counter sends the NIU two words of input data. The specific meaning of this data depends on the present content of the output data received from the NIU.

Process Data Input Word, Basic Format

Unless the output words contain the Read Counter command, the input data word has the following content:


Process data word 0
Process data word 1
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Parameter mirroring
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Command code mirroring
Parameter mirroring
Error bit

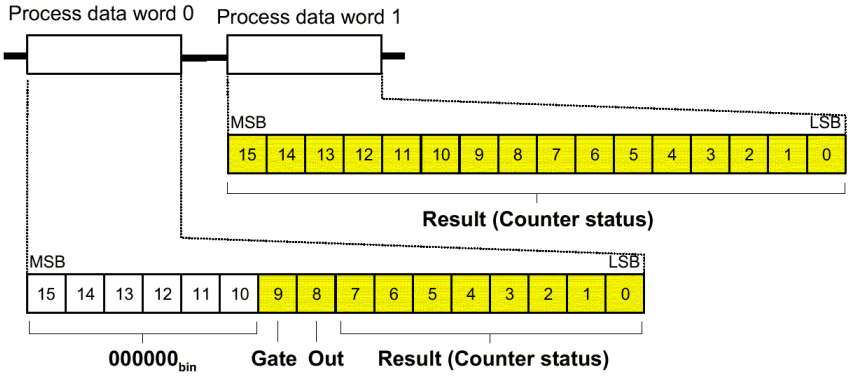
Bit 15 of Input Word 0 is set if:

- The module is not yet configured
- There is an invalid parameter in the default operating mode.
- The counter is read without an operating mode having been present.
- A reserved bit is set.

If Word 1 is not needed, its content is not evaluated.

Process Data Input Word, Read Counter Format

If the output words contain the Read Counter command, the input data word has the following content:


Process data word 0
Process data word 1
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Result (Counter status)
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
000000bin
Gate
Out
Result (Counter status)

- The command code (00000) is mirrored in bits 15 through 10 of Word 0.
- The status of the control input (gate) is indicated in bit 9.
- The status of the output (Out) or the result of evaluating of a relational condition is indicated in bit 8.
- Bits 7 through 0 of Input Word 0 and Input Word 1 contain the results of the counting.
- In time measurement mode, Input Word 1 contains the 16-bit value. Bits 0 through 7 of Input Word 0 are not used.
- In frequency measurement mode or event counting mode, Input Word 1 and bits 7 through 0 of Input Word 0 contain the 24-bit measurement or count value, where bit 7 of word 0 is the MSB.

Format of the High-speed Counter Module Commands (Process Data Outputs)

The NIU can send commands to the High-speed Counter module to do the following:

- to set the operating mode
- to control the module's functions
- to specify general conditions
- to read the module's firmware version
- to preset initial / final values
- to stop or start the counter
- to default the counter parameters

Command Sequence

Some of these commands must be sent in a specific sequence:

1. System settings (optional) are first. If no system settings are required, this step can be skipped.
2. Operating Mode selection is next.
3. Read Counter (optional). If the NIU does not need to read the counter, this step can be skipped.

The other output commands can be sent to the High-speed Counter module at any time:

- Read Firmware Version
- Preset Initial Value and Preset Final Value
- Stop Counter and Start Counter
- Set Counter to Default

Assuring Data Consistency for the Output Commands

It is important to have data consistency of two output words to prevent misinterpretation of the values. If the second output word is related to the first, the High-speed Counter module must receive them together. Otherwise, the second word will contain an old value still present in the input word from an earlier transmission. If that happens, the data will not be accepted properly.

To prevent this, the NIU can send Output Word 1 first with the default value, and any command code other than that required. 000000_{bin} (Read Counter) is one possibility for this command code; it has no effect on the parameterization of the module. If the module has not been configured before a value is preset, or if no operating mode has been commanded, bit 15 of Input Word 0 will indicate an error after the transmission of this code. This error message can be ignored. It has no effect on the preset value.

Next, transmit Output Word 0 with the command required for presetting the value, without changing Output Word 1. The output words are mirrored in the two input words. Input words 0 and 1 must now contain the command code and the required preset. Bit 15 of Input Word 0 must no longer indicate an error now. That shows that the High-speed Counter module has adopted the value required.

Note that the High-speed Counter module will not accept a new value if the NIU sends the same code for presetting the value several times in succession. To change a preset value, at least one other command code has to have been transmitted.

If it has become evident that data consistency is no longer ensured, e.g., during transmission of the initial value, the command sequence may appear as described by the table below.

Action	*Commands in Hexadecimal Format*		*Commands in Binary Format*	
	Output Word 0	*Output Word 1*	*Output Word 0*	*Output Word 1*
Preset initial value	4000	1111	0100 0000 0000 0000	0001 0001 0001 0001
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 *Input Word 1 is NOT the same as Output Word 1*			

This acknowledgement shows that data consistency is not assured. The initial value must be retransmitted by sending Output Word 1 followed by Output Word 0, as described above.

Enter initial value (transmit Word 1)	0000	1111	0000 0000 0000 0000	0001 0001 0001 0001
Reenter initial value (transmit Word 0)	4000	1111	0100 0000 0000 0000	0001 0001 0001 0001
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1.			

Reference to the Output Commands

All of the commands and parameters that can be sent to the High-speed Counter module by the NIU are summarized below for reference. They are explained in detail on the following pages.

Frequency Measurement

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	0	1	0	0	Parameter									

Event Counting

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	0	1	0	1	0	0	R	Gate			D	Output		

Time Measurement

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	0	1	1	0	0	0	Resolution		Out	Type	0	Relational Condition		

Pulse Generation

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	0	1	1	1	0	0	0	0	0	Factor				

System Settings

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	1	1	0	0	Input Type		Source – Gate Logic				Reset	Pulse Length		

Read Firmware Version

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	1	1	1	1	x	x	x	x	x	x	x	x	x	x

Preset Initial Value

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	1	0	0	0	0	0	0	Initial value							
Word 1	Initial value															

Preset Final Value

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	1	0	1	0	0	0	0	Final value							
Word 1	Final value															

Stop Counter

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	1	0	0	0	x	x	x	x	x	x	x	x	x	x

Start Counter

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	1	0	0	1	x	x	x	x	x	x	x	x	x	x

Set Counter to Default

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	1	0	1	0	x	x	x	x	x	x	x	x	x	x

Read Counter

Output	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x	x

The System Settings Command

The System Settings command from the NIU to the High-speed Counter module is optional; it is not needed for all operating modes. If needed, however, it must be sent as the first output command to the module, before sending the command that specifies the operating mode. All System Settings except Pulse Length are accepted immediately in an activated mode.

The System Settings command uses only Word 0 of the module output data.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	0	0	Input Type		Source – Gate Logic Operation				Reset	Pulse Length		

Effects of the System Settings in Each Operating Mode

The parameters supplied by the System Settings command have different uses, depending on the operating mode.

	Input Type	*Source – Gate Logic Operation*	*Reset*	*Pulse Length*
Frequency Measurement mode	00 = none 01 = switch filter 11 = enable source/gate operation	If source – gate operation is enabled in bits 9 – 8, then bits 7 – 4 set up relational operations between the source and gate input signals (for example, both on or both off).	For all modes, bit 3 determines whether a bus reset will reset the module's output, stop counting, and clear the operating mode setting.	Not used
Event Counting mode	00 = none 01 = switch filter 11 = enable source/gate operation			Sets length of the output pulse
Time Measurement mode	00 = none 01 = switch filter 11 = enable source/gate operation			Not used
Pulse Generator mode	00 = none 10 = setting for pulse generator	Not used		Not used

System Settings: Input Type

The input type parameter can be used in all operating modes. This setting has three basically different functions. In all operating modes, it can establish an input filter. In Pulse Generator mode, it sets up Pulse Generator operation. In all modes except Pulse Generator mode, it can enable source – gate logic operations.

Bits 9 and 8 binary	*Status Word hex*	*Function*
00	300x	Source and gate direct, each 100kHz filter
01	310x	Source and gate filter for mechanical contacts
10	320x	Enable Pulse Generator
11	33xx	Source – gate logic operation (not used in Pulse Generator mode).

Electronic switches are recommended for use with the High-speed Counter module. If mechanical switches such as relays are used, source and gate filters should be set up to minimize the effects of the contacts bouncing. Filtering may not eliminate the effect of mechanical contacts bouncing. When solid-state switches or light barriers are used, the filter must be switched off. If different types of switches (mechanical and electronic) are used at the source and gate inputs, the effects of wiring with and without filtering should be checked beforehand.

The High-speed Counter module always accepts the latest input configuration. For example, it is not possible to set a filter for mechanical contacts first and then perform a source-gate logic operation. In that case, only the source-gate operation would be accepted and the filter would no longer be active.

System Settings: Source – Gate Logic Operation

Source – gate logic operation can be used in all modes except Pulse Generator. In source – gate logic operation, a new source signal is formed as a result of the logic operations performed on the digital source and gate input signals. The original source signal is no longer available, The original gate signal can still be used. This function can perform most common logic operations on the two module inputs, according to the setup made in bits 7 – 4 of the System Settings command:

Bits 7 - 4	*Status Word hex*	*New Source Signal is Result of this Operation:*
0001	331x	New source = Source NOR Gate
0011	333x	New source = Gate signal inverted
0101	335x	New source = Original source signal inverted
0110	336x	New source = Source EXOR Gate
0111	337x	New source = Source NAND Gate
1000	338x	New source = Source AND Gate
1100	33Cx	New source = Gate
1110	33Ex	New source = Source OR Gate

Results of Source – Gate Logic Operations on the Source and Gate Inputs

The following table compares the results of the Source – Gate operations for the possible combinations of the original source input signal and the gate input signal. In the table, S' indicates the new source signal.

Gate	*Source*	*OR*	*EXOR*	*AND*	*NOR*	*NAND*	*NOT S*	*G*	*NOT G*
0	0	0	0	0	1	1	1	0	1
0	1	1	1	0	0	1	0	0	1
1	0	1	1	0	0	1	1	1	0
1	1	1	0	1	0	0	0	1	0

Other logic operations can be set up using different values in bits 7 – 4 of the Command word. The table below compares the results of logic operations on the gate and source inputs that can be produced using different values in the Command word.

Gate	*Source*	*0000*	*0010*	*0100*	*1001*	*1010*	*1011*	*1101*	*1111*
0	0	0	0	0	1	0	1	1	1
0	1	0	1	0	0	1	1	0	1
1	0	0	0	1	0	0	0	1	1
1	1	0	0	0	1	1	1	1	1

Defining a Function

To define a function for Source – Gate logic operations, create a table that shows all four possible combinations of the gate and source inputs in the first two columns, then add the intended state of the new source' input for each of these combinations. For example, if source' should always be 1 except when the original source input is 1 and the gate input is 0, the table looks like the one below. Program the command by setting the Command word bits to match, as shown (for this example 1011 from bit 7 to 4):

Gate	*Source*	*New Source'*	*Command Word Bits*
0	0	1	4
0	1	1	5
1	0	0	6
1	1	1	7

System Settings: Reset

The Reset function can be used to control how the High-speed Counter module will react to a bus reset. By default, the module resets its output, stops all counting operation, and clears the currently-selected operating mode. This can be changed so that a bus reset will not affect the operation of the module, by using bit 3 of the output Command word:

Bit 3	Meaning
0	Bus reset resets the module output, stops counting, clears the operating mode
1	Bus reset has no effect on module

System Settings: Pulse Length

The Pulse Length parameter can be used to change the length of the output pulse in event counting mode. The default pulse length is 100ms. The Pulse Length parameter can be changed at any time. However, the change is not effective until Event Counting mode is set.

Note: If the pulse length is set during event counting, after the value has been changed the command for setting Event Counting mode must be resent.

The Pulse Length parameter is set using bits 0 to 2 of the Command word:

Bits 2, 1, 0	Pulse Length
000	10ms
001	50ms
010	100ms
011	200ms

Bits 2, 1, 0	Pulse Length
100	300ms
101	400ms
110	500ms
111	1000ms

Setting the Operating Mode to Frequency Measurement

The High-speed Counter module can measure frequencies up to 100kHz. To place the module in Frequency Measurement mode, the NIU sends a command to the module using Output Word 0. Output Word 1 is not used.

Output Word Format for Frequency Measurement

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	0	0	Parameter									

Bits 9 to 0 contain a time value or a gate state to start counting.

Parameter	*Description*	*Decimal*	*Hexadecimal*	*Binary*
Time-controlled	Time gate after which a count value is accepted	1 to 1000	1 to 3E8	00 0000 00001 to 11 1110 1000
State-controlled	Gate state with which a count value is accepted	1020 to 1023	3FC to 3FF	11 1111 1100 to 11 1111 1111

When a time or state set is reached the counter is reset to the initial value.

Time-controlled Frequency Measurement

With time-controlled measurement, the parameter value (see above) specifies the gate time after which measurement is performed, as a multiple of 10ms. As the count gate time increases, the count frequency decreases.

- Count gate time = Parameter value X 10ms
- Count resolution = 1 / Count time = 1 / (parameter value x 10ms)
- Frequency = Count value x 100 / Parameter value

The gate time should be selected to match the needs of the application. Longer gate times provide greater resolution and accuracy. Shorter gate times provide rapid response but decreased resolution. If the application requires simple count value processing, a resolution of 1Hz avoids the need for converting the count value into a frequency.

Time-Controlled Frequency Examples

The following table shows some typical count times and frequencies. For example, if the count time parameter is 10 (decimal), then the count time is 0.1 second and the count frequency is 10Hz. If the count time parameter is 1000, then the count time is 10 seconds and the count frequency is 0.1Hz.

Count Time Parameter		*Time in Seconds*	*Resolution in Hz / LSB*
(decimal)	*(hex)*		
1	1001	0.01	100
2	1002	0.02	50
10	100A	0.1	10
50	1032	0.5	2
100	1064	1	1
500	11F4	5	0.2
1000	13EA	10	0.1

State-controlled Frequency Measurement

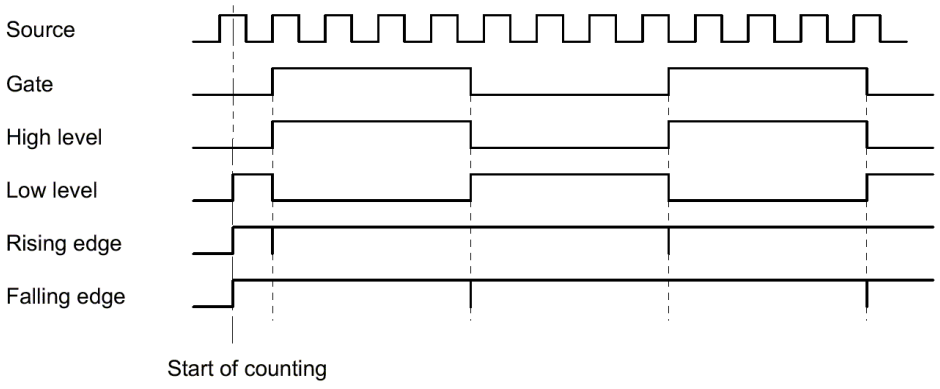
With state-controlled measurement, the parameter value (see above) specifies the *state* of the gate input after which counting is performed or the count value is accepted. The following choices are possible:

Count Gate Parameter		Gate State for Counting or Acceptance of Count Value	
(decimal)	(hex)		
1020	13FC	High level	Counting occurs while the gate input is High. Counting stops when it changes to Low. The last count value is accepted into the input data. When the gate input is High again, counting restarts at 0.
1021	13FD	Low level	Counting occurs while the gate input is Low. Counting stops when it changes to High. The last count value is accepted into the input data. When the gate input is Low again, counting restarts at 0.
1022	13FE	Rising edge	Counting starts immediately after the command is received. The current count value is accepted into the input data each time the gate signal rises. The counter is reset to 0 and counting continues.
1023	13FF	Falling edge	Counting starts immediately after the command is received. The current count value is accepted into the input data each time the gate signal falls. The counter is reset to 0 and counting continues.

Counting Phase Depending on the Gate State

If the condition for counting (for example, gate input High) is already satisfied when the module receives the command, the first count occurs immediately. Depending on the application, this counting cycle may need to be rejected because only part of the gate signal has been registered.

This is illustrated below. The "source" train shows the pulses to be counted. The "gate" pulse train represents the gate input. Counting starts when the NIU sends the Frequency Measurement command (in the output data). Whether counting actually occurs depends on the parameter and the gate signal.



Setting the Operating Mode to Event Counting

If the module should count the occurrences of a specific event, send the module an Event Counting command using Output Word 0. Parameters in Word 0 specify the conditions for event counting. Bits 9 and 8 of Word 0 must be set to 0. Output Word 1 is not used.

Output Word Format for Event Counting

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0	R	Gate			D	Output		

Repetitions
0 = single count
1 = constant repeat

Count Direction:
0 = down
1 = up

Counting starts immediately after the module receives the command. In Event Counting mode, the operating range for all options is up to 100kHz.

Repetitions: Specify single count or repeated counting

If Repetitions is set to 0, counting stops when the final value is reached and the count value remains at that value. If Repetitions is set to 1, the counter is reset when the final value is reached and the count is repeated from the initial value.

Gate: Specify how the Gate input affects counting

The Gate parameter specifies how the state of the Gate input signal affects the counting process. The choices are listed below. When the gate signal is used to start counting, a response time of 200 microseconds must be allowed. Count pulses that occur within this period do not register. This response time applies to starting and stopping the count.

Bit 6 / 5 / 4		*Meaning*
bin	*dec*	
000	0	No function
001	1	Count at High level
010	2	Count at Low level
011	3	Start counting on rising edge of Gate input
110	4	Start counting on falling edge of Gate input
101	5	Reserved
110	6	Reserved
111	7	Count at High level, reset the count value on a rising edge

Count Direction: Select up or down counting

Bit 3 determines the count direction. Note that the default count direction is DOWN (bit 3 = 0). Starting event counting with a parameter of 1400H produces a down counter. If no initial or final value is set, counting starts and ends at 0. The final value is reached if an up counter counts from FFFFFFH to 0 or a down counter counts from 0 to FFFFFFH.

Output: Set up the operation of the module output

This parameter determines the operation of the module's output when the final count value is reached. The standard length of a high and a low pulse is 100ms. It can be changed using the System Settings output command.

Bit 2 / 1 / 0		*Meaning*		*Initial Output State*
bin	*dec*			
000	0	No function	Output not active	low
001	1	High pulse	Positive pulse generated	low
010	2	Low pulse	Negative pulse generated	high
011	3	Toggle L	Previous state inverted	low
110	4	Toggle H	Previous state inverted	high
101	5	High	Output high	low
110	6	Low	Output low	high
111	7	Reserved	Reserved	-

Setting the Operating Mode to Time Measurement

If the module should count the occurrences of a specific event, the NIU sends a command in the output data to place the module in Time Measurement mode using Output Word 0. Additional parameters in Word 0 specify the conditions for time measurement. Bits 9, 8, and 3 of Word 0 must be set to 0.Output Word 1 is not used.

The count value in time measurement mode occupies 16 bits. Measurement starts on a rising edge. Measurement of pulse length ends on a falling edge. Measurement of period starts on the next rising edge. Only when measurement is complete is the count value accepted into the process data. If no counting edge is detected within the timeout, the count value is cleared. An error message is generated if a timeout occurs.

Output Word Format for Time Measurement

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	Resolution		Out	Type	0	Relational Condition		

Output:
0 = Output not used
1 = Set output if relation condition satisfied

Type:
0 = Measure period
1 = Measure pulse length

Resolution: Specify the increments for all parameters

Resolution determines the value of the least significant bit, as shown below. The indicated resolution is valid for all values, including preset conditions such as an initial or final value. For example, if the resolution is 2ms, the initial value would be entered as a multiple of 2ms. So an entry of 25, multiplied by the 2ms resolution, would give an initial value of 50ms.

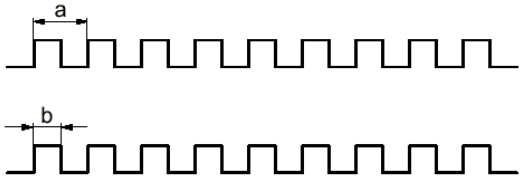
Bit 7 / 6	*Meaning*	*Range*	*Timeout After*
00	2 microseconds	(without relational condition): 250µs to 131ms (with relational condition): 1ms to 131 ms	150ms
01	2 milliseconds	2ms to 131 seconds (2 minutes, 11 seconds)	131 seconds
10	10 milliseconds	10 ms to 655 seconds (10 minutes, 55 seconds)	655 seconds
11	reserved	-	-

Out: Specify whether the output will be set

The Output parameter determines whether the output will be set if a specific relational condition is satisfied (Bit 5 = 1) or not (Bit 5 = 0).

Type: Specify pulse period or pulse length measurement period

The Type parameter determines whether the measurement period will be of pulse period (see "a" below; Bit 4 = 0), or pulse length (see "b" below; Bit 4 = 1).



Relational Condition: Set up the logical operation that will control the output

The Relational Condition parameter specifies a condition for the output behavior during time measurement. Compliance with the limit values specified in the relation condition is indicated through the output of bit 8 (Out). Only the initial and/or the final value from the event counting can be use as limit values. Because the count value only occupies 16 bits, only the lower 16 bits of the initial value and the final value are taken into account.

Relational Conditions Parameter

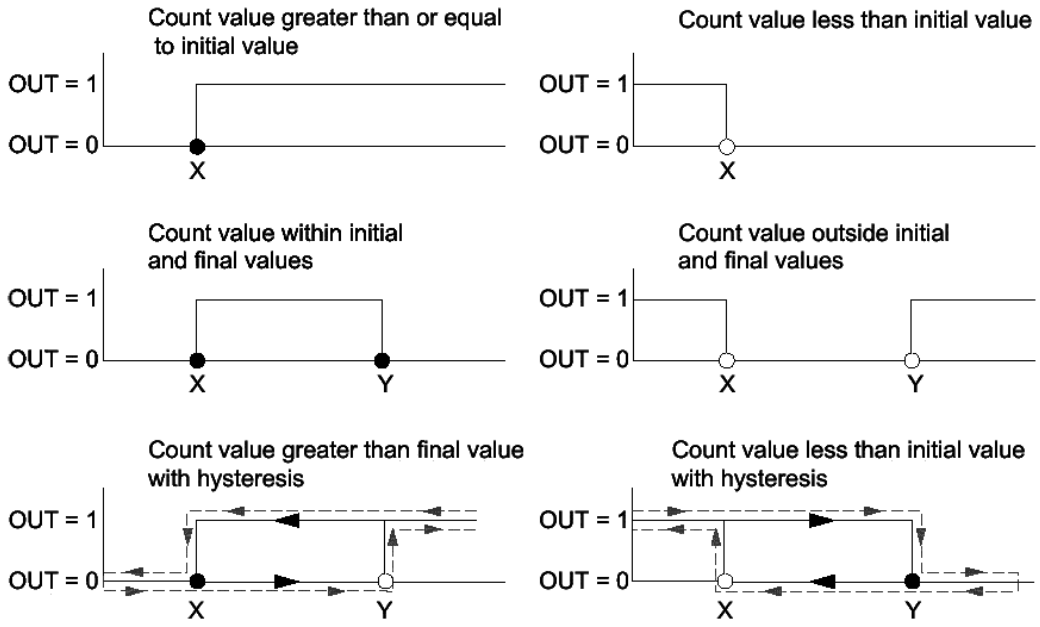
Bit 2 / 1 / 0		*Meaning*
bin	*dec*	
000	0	No relational condition
001	1	Count value greater than or equal to initial value
010	2	Count value less than initial value
011	3	Count value within initial and final values
110	4	Count value outside initial and final values
101	5	Count value greater than final value with hysteresis
110	6	Count value less than initial value with hysterisis
111	7	reserved

Whether or not a limit value is included in the condition depends on the condition. Internally, the module reduces each condition to a comparison of count value less than initial value and/or count value greater than final value.

The illustration below shows the operation of the output with different selections for relational conditions. In the illustration:

X = initial value Y = final value

● = limit value included o = limit value not included

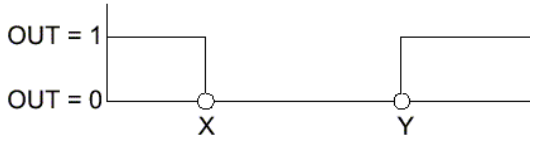


Effect of Relational Condition If the Output is Used

If the output is being used (output bit 5 is set to 1), then bit 8 *in Input Word 0* reflects the state of the output. If the relational condition is satisfied. the output is set and bit 8 in Input Word 0 shows a 1, reflecting the output state. If the relational condition is not satisfied, the output is reset and a 0 is shown in bit 8 of Input Word 0.

Example of Relational Condition

The following illustration shows the effect of a relational condition:



- If the count value is less than the initial value, the relational condition is satisfied and OUT is set to 1.
- If the count value is greater than or equal to the initial value, and less than or equal to the final value, the relational condition is not satisfied and OUT is set to 0.
- If the count value is greater than the final value, the condition is satisfied and OUT is set to 1.

Effect of Relational Condition If the Output is Not Used

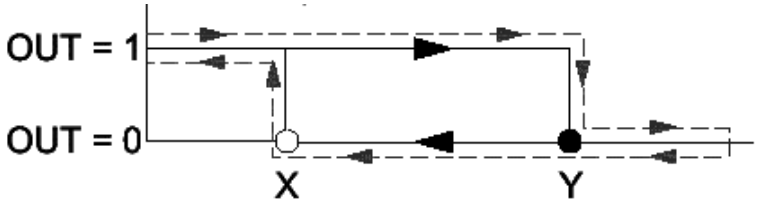
If the output is not being used (output bit 5 is set to 0), then once the relational condition is satisfied, the bit for the output is set in the input data word (bit 8 of Word 0 = 1). Input bit 8 remains at 1 unless it is specifically reset. Bit 8 of Output Word 0 is set to 1 until bit 8 in the input data Word 0 changes to 1. If the relational condition is not satisfied, a 0 appears in the input data word (bit 8 of Word 0 = 0).

Effect of Hysterisis

The bottom two diagrams on the previous page show the effect of hysteresis. In the diagrams, the dashed line illustrates the output state as a function of the previous state of the OUT output bit and the measured value. If, for example, in the diagram below, the measurement is between the initial and final values, OUT can be either 0 or 1. If OUT was 0, it remains at 0. If OUT was 1, it remains at 1. Hysteresis can be used to stabilize the output behavior of measured values that fluctuate around certain limit values.

Example 2

This illustration again shows the behavior of an output with hysteresis:



- If the time measured has not yet been greater than or equal to the final value, the condition is satisfied and OUT is 1.
- If the time measured is greater than or equal to the final value, the condition is no linger satisfied and OUT is 0.
- If the time measured becomes smaller, but still remains greater than or equal to the initial value, OUT remains 0.
- If the time measured is less than the initial value, OUT becomes 1.
- OUT only returns to 0 again if the measured value becomes greater than or equal to the final value.

Setting the Operating Mode to Pulse Generator

In Pulse Generator mode, the High-speed Counter module can produce frequencies from 1kHz through 10kHz. Frequencies can be selected in 500Hz increments as part of the module configuration.

The NIU sends a command in the output data to place the module in Pulse Generator mode using Output Word 0. Output Word 1 is not used.

Output Word Format for Pulse Generation

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	1	0	0	0	0	0	Factor				

Setting Up the pulse frequency

To set up the pulse frequency, the output word must specify the number of 500Hz increments in the intended frequency. For example, for 1000Hz, there would be two 500Hz increments, so the output word would contain the value ("factor") 2. The table below shows the pulse frequencies for each possible factor value that can be specified in the output word.

Dec	*Hex*	*Nominal Frequency*	*Actual Frequency*	*Error in %*
0	00	1000	1000	0
1	01	1500	1497	-0.2
2	02	2000	2000	0
3	03	2500	2500	0
4	04	3000	3012	0.4
5	05	3500	3521	0.6
6	06	4000	4000	0
7	07	4500	4505	0.11
8	08	5000	5000	0
9	09	5500	5495	-0.09

Dec	*Hex*	*Nominal Frequency*	*Actual Frequency*	*Error in %*
10	0A	6000	5988	-0.2
11	0B	6500	6494	-0.09
12	0C	7000	6993	-0.1
13	0D	7500	7519	0.25
14	0E	8000	8000	0
15	0F	8500	8475	-0.29
16	10	9000	9009	0.1
17	11	9500	9525	0.26
18	12	10000	10000	0

System Settings for Pulse Generation

In addition to setting up the pulse frequency as explained above, Pulse Generator mode must also be selected using the System Settings command ("Input Type" = 10, Pulse Generator mode) as described previously.

Reading the Counter

The application can read the present value of the counter using the optional Read Counter command. If this command is used, it must be sent after the Operating Mode commands. The Read Counter command can be used in all operating modes.

The NIU sends the Read Counter command to the module using Output Word 0, bits 15 - 8. Bits 7 through 0 are not relevant. Output Word 1 is not used.

Output Word Format for Read Counter

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	x	x	x	x	x	x	x	x

Content of the Input Words

After the module receives a Read Counter command, it sends the information in the input data words as shown below . The input data format for Time Measurement is different than for Event Counting / Frequency Measurement modes.

Input Data for Time Measurement mode

Bit 15 (E) = Error bit, 0 = no error
Bits 14 - 10 = Mirror of the command bits, i.e. all 0
Bit 9 (G) = Status of the Gate input signal
Bit 8 (S) = Status of the output or result of the evaluation of the relational condition without using the output
Bits 0 - 7 of Word 0 (x) = don't care
Word 1 = 16-bit measured value

Input Word 0																Input Word 1															
high byte								low byte								high byte								low byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
E	0	0	0	0	0	G	S	x	x	x	x	x	x	x	x	Time Measurement mode: 16-bit measured value															

Input Data for Event Counting or Frequency Measurement mode

Bit 15 (E) = Error bit, 0 = no error
Bits 14 - 10 = Mirror of the command bits, i.e. all 0
Bit 9 (G) = Status of the Gate input signal
Bit 8 (x) = not used
Bits 0 - 7 of Word 0 = most significant bits of the 24-bit count value
Word 1 = less significant bits of the count value. The count value must be masked out of the two input words:
count = (IN (0) & 00FFH) x 65536 + IN (1)

Input Word 0																Input Word 1															
high byte								low byte								high byte								low byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
E	0	0	0	0	0	G	x	Event Counting or Frequency Measurement mode: 24-bit measured value																							

Reading the Firmware Version

The application can read firmware version of the High-speed Counter using the Read Firmware Version command. This command can be used at any time. Only Output Word 0 is used for this command. The command is mirrored immediately in Input Word 0. Input Word 1 contains the firmware version.

Output Word Format for Read Firmware Version

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	1	1	x	x	x	x	x	x	x	x	x	x

Input Words Returned Following a Read Firmware Version Command

In response to the Read Firmware Version command, the High-speed Counter module sends back the two input data words. Input Word 0 mirrors the command. Input Word 1 contains the firmware version in the format A.BC.

Input Word 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	1	1	x	x	x	x	x	x	x	x	x	x

Input Word 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
A				B				C				x			

In the example response below, Input Word 1 contains the value 1360H. This corresponds to firmware version 1.36.

Input Word 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	0	0	1	1	0	1	1	0	0	0	0	0
1				3				6				0			

Presetting an Initial Value or Final Value

The application can specify initial and final values for Event Counting or Time Measurement mode using the Preset commands. For Event Counting, the initial and final values can be 24-bit values. For Time Measurement, the initial and final values must be 16-bit values.

The Preset commands can be sent at any time. They are accepted immediately, even during counting or time measurement.

- If a new initial value is set while counting, the counter is set to this value immediately, regardless of its current state.
- If a new final value is set while counting, the value is accepted immediately for the current count.

Repeat Counting if No Initial value has been Set

If no initial value has been set for repeat counting, the counter starts at 0 (*not 1*). It counts the number of times specified by the final value, then resets to 0 on the next pulse. For example, if there is no initial value and the final value is 10, the counter increments from 0 to 9 (10 counts), then resets to 0.

Output Word Format for Preset Initial Value Command

Output Word 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	0	0	0	Initial value							

Output Word 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Initial value															

Output Word Format for Preset Final Value Command

Output Word 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	0	0	0	0	Final value							

Output Word 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Final value															

Resolution of the Preset Values

When entering initial and final values for Time Measurement mode, any resolution that has been set by the mode command also applies to these initial and final values. For example, it the resolution will be 2ms and the initial value will be 50ms, then the initial value must be entered as 25 decimal (19H).

Start and Stopping the Counter in Event Counting Mode

Event counting starts as soon as the High-speed Counter receives the Event Counting mode command. It is not necessary to send a Start Counter command to initiate counting.

If the count should start at a defined initial state, first send the Set Counter to Default command to clear the counter. See below.

The NIU sends the Stop Counter command (2000H) to stop counting, and the Start Counter command (2400H) to restart counting.

The count value is frozen by the Stop Counter command. It resumes again at the frozen value when the Start Counter command is received.

The Start Counter and Stop Counter commands use Output Word 0. Output Word 1 is not used.

Output Word Format for Stop Counter Command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	0	x	x	x	x	x	x	x	x	x	x

Output Word Format for Start Counter Command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	x	x	x	x	x	x	x	x	x	x

Defaulting the Counter

The Set Counter to Default command is valid in all operating modes.

Event counting starts as soon as the High-speed Counter receives the Event Counting mode command. If the counter should start at a predefined default condition, the NIU must send the Set Counter to Default command (2800H).

The Set Counter to Default command does the following:

- it sets the Pulse Length to the default value
- it sets the input configuration to 100kHz
- it stops the counter
- it clears the operating mode

The Set Counter to Default command does NOT change the configured Reset behavior.

If the system is being tested, use this command to default the counter before switching to a new operating mode.

The Set Counter to Default command uses Output Word 0. Output Word 1 is not used.

Output Word Format for Set Counter to Default Command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	1	0	x	x	x	x	x	x	x	x	x	x

Wiring and Programming Examples

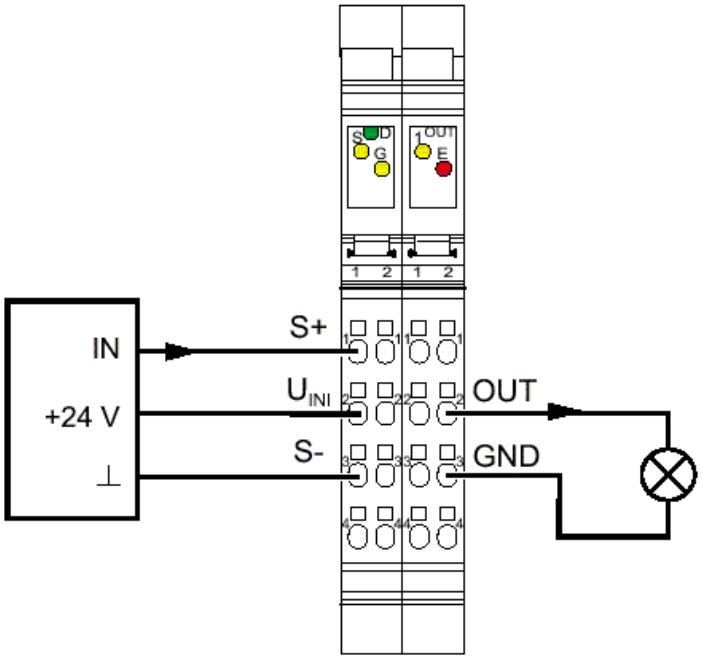
The examples in this section show typical device wiring and programming sequences for event counting and for time measurement.

Event Counting

In this example, the module is used for counting up. A light barrier is connected to the source input as shown below. This barrier provides the counting pulses.

Counting starts at 123H. The module's output turns on an indicator light when counting starts. The output needs to be inverted each time the count reaches 132H.

Wiring for the Event Counting Example



Output Command for the Event Counting Example

The NIU sends the following command to the High-speed Counter module in this example:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0

Command

Gate – Source Logic not used

100 = invert previous output state when final value is reached, set high at initial state

1 = constant repeat

Count Direction: 1 = up

Programming Sequence for the Event Counting Example

Action	*Commands in Hexadecimal Format*		*Commands in Binary Format*	
	Output Word 0	*Output Word 1*	*Output Word 0*	*Output Word 1*
Set counter to default	2800	xxxx (don't care)	0010 1000 0000 0000	xxxx xxxx xxxx xxxx (don't care)
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 (Input Word 1 is not relevant at this point)			
Preset initial value to 123H (see below)	4000	0123	0100 0000 0000 0000	0000 0001 0010 0011
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			
Preset final value to 132H	5000	0132	0101 0000 0000 0000	0000 0001 0011 0010
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			
Set operating mode = event counting, up counting, output active, output = toggle	148C	xxxx	0001 0100 1000 1100	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0			
Read counter	0000	xxxx	0000 0000 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until (Input Word 0 & FC00H) mirrors (Output Word 0 & FC00H)			
Read count value	Count value = Input Word 1 In this example, the counting range is from 123H to 132H, so the count value only occupies Input Word 1. If the value occupies more than 16 bits, the value must be masked out of the two input words, as described.			

If the preset initial value and/or final value are 24-bit values, the preset commands have this format:

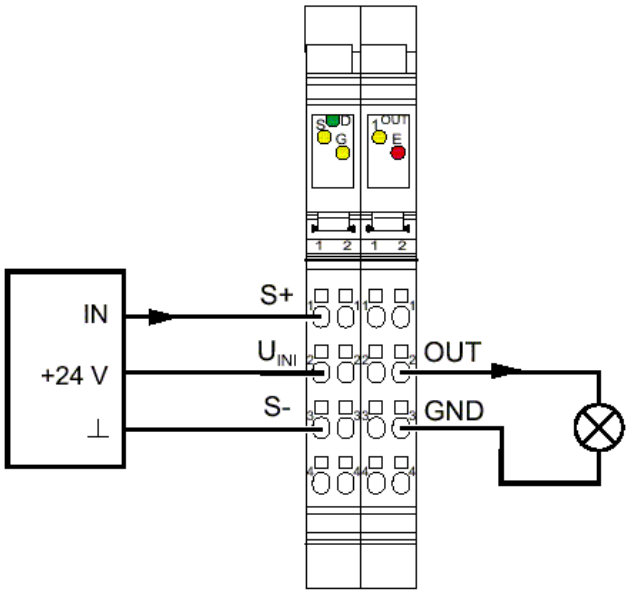
Preset initial value 123456H	4012	3456	0100 0000 0001 0010	0011 0100 0101 0110
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			
Preset final value 789ABCH	5078	9ABC	0101 0000 0111 1000	1001 1010 1011 1100
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			

Wiring and Programming Examples: Time Measurement

In this example, the module is used to measure the length of pulses. The output is to follow a hysteresis loop with the relational condition: "count value less than initial value with hysteresis".

Wiring for the Time Measurement Example

Wiring for this example is the same as for the previous example:



Output Command for the Time Measurement Example

The NIU sends the following command to the High-speed Counter module in this example:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	0	1	1	1	0	1	1	0

Command

Resolution: 01 = 2ms
When specifying initial and final values note the resolution specified for time measurement.

Relational Condition: 110 = Count value less than initial value (hysteresis)

Type:
1 = Measure pulse length

Out:
1 = Set output if relational condition is satisfied

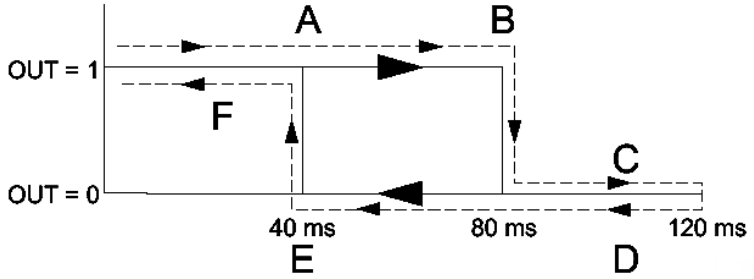
Program Sequence for the Time Measurement Example

Action	*Commands in Hexadecimal Format*		*Commands in Binary Format*	
	Output Word 0	*Output Word 1*	*Output Word 0*	*Output Word 1*
Set counter to default	2800	xxxx (don't care)	0010 1000 0000 0000	xxxx xxxx xxxx xxxx (don't care)
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0			
Preset initial value to 14H (see below)	4000	0014	0100 0000 0000 0000	0000 0000 0001 0100
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			
Preset final value to 28H	5000	0028	0101 0000 0000 0000	0000 0000 0010 1000
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			
Set operating mode = time measurement, with parameters as described	1876	xxxx	0001 1000 0111 0110	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0			

The following steps are not needed if only the output behavior is important for the application:

Read counter	0000	xxxx	0000 0000 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until (Input Word 0 & FC00H) mirrors (Output Word 0 & FC00H)			
16-bit count value	Count value = Input Word 1			
Time in ms	Time = count value x resolution: resolution = 2ms			

When the mode command is sent, the High-speed Counter module immediately starts counting (time measurement) the signals at the input. The pulse length starts at 0ms, and slowly increases (see A below). As long as the pulse length is less than the final value (80ms), the output remains at 1. When the pulse length equals the final value (B in the diagram) the output is set to 0. The pulse length continues to increase (C below) until it reaches 120ms. It then decreases again (segment D). If the pulse length is equal to the initial value (40ms, point E below) the output is set to 1. If the pulse length shortens further, the output remains at 1.

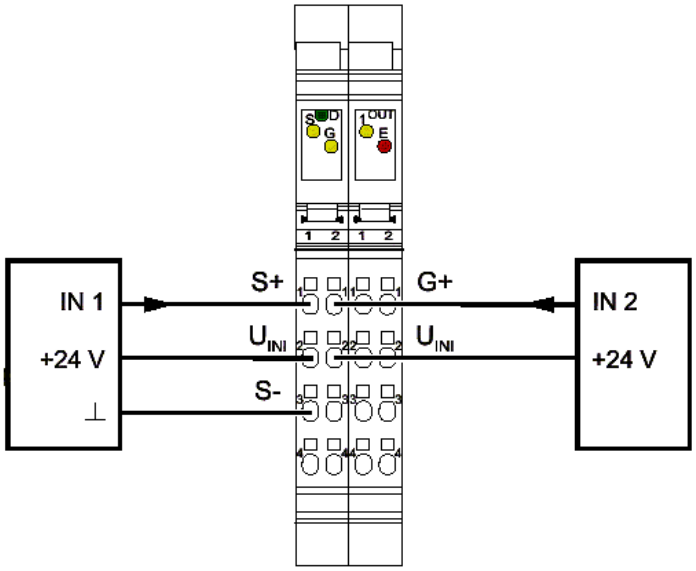


Wiring and Programming Examples: Time Measurement using Limit Switches

In this example, two limit switches are connected to the module's source and gate inputs. The application measures the time during which the source and gate limit switches are both at 1 simultaneously. If a limit value is exceeded, it will be detected.

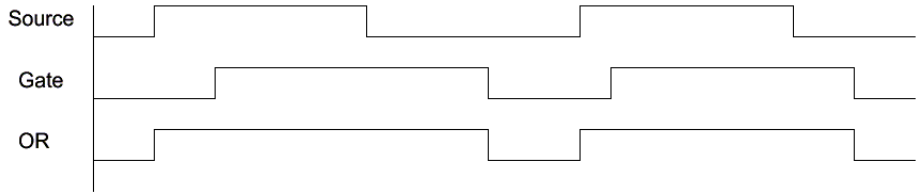
A light barrier is connected to the source input, and another sensor is connected to the gate input. The output is not used. The module provides the results of evaluating the relational condition in Input Word 1, bit 9.

Wiring for the Time Measurement with Limit Switches Example



Setting up the Relational Operation for the Source and Gate Inputs

In this example, the module should perform a logical OR on the source and gate inputs to produce the new source' input:



Before setting the operating mode, the NIU must specify this relational operation using the following System Settings command:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	0	0	1	1	1	1	1	0	0	0	0	0
Command						Input Type 11 = Logic Operation		Source – Gate Logic Operation: 1110 = Logical OR				Reset 0 = no response	Pulse Length: not relevant		

Presetting the Initial Value

The NIU next presets the initial value with the limit value. During operation, the Out bit in the Input word will be used to indicate when the limit value has been exceeded. In this example, the limit is 30 seconds. Therefore, an initial value of 3000ms is preset. The resolution will be 2ms. The value entered in the parameter word for the Default Initial Value command is 15000 decimal (3A98H).

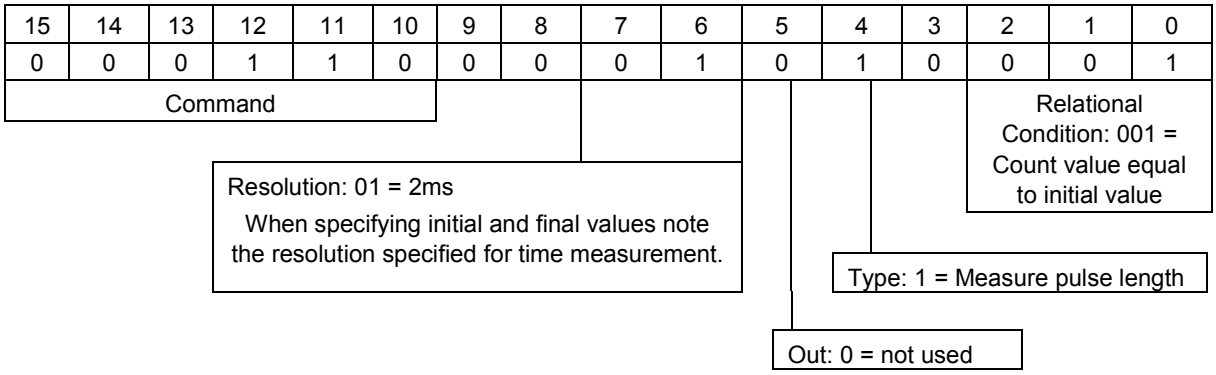
The initial value is preset using:

Word 0 = 4000H
Word 1 = 3A98H

These two words should have data consistency. If that is not possible, the NIU should send Word 1 then Word 0.

Setting the Operating Mode to Time Measurement

After setting up the relational operation (and other system settings) and entering the presets as described above, the NIU can send the Operating Mode command to the module, placing it in Time Measurement mode.


15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 1 1 0 0 0 0 1 0 1 0 0 0 1
Command
Resolution: 01 = 2ms
When specifying initial and final values note the resolution specified for time measurement.
Relational Condition: 001 = Count value equal to initial value
Type: 1 = Measure pulse length
Out: 0 = not used

Program Sequence for Time Measurement with Limit Switches Example

Action	*Commands in Hexadecimal Format*		*Commands in Binary Format*	
	Output Word 0	*Output Word 1*	*Output Word 0*	*Output Word 1*
Set counter to default	2800	xxxx (don't care)	0010 1000 0000 0000	xxxx xxxx xxxx xxxx (don't care)
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0			
System Settings: logic operation on source - gate active command	33E0	xxxx	0011 0011 1110 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0			
Preset initial value to 3A98	4000	3A98	0100 0000 0000 0000	0011 1010 1001 1000
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0 and Input Word 1 mirrors Output Word 1			
Time measurement mode, pulse length measurement	1851	xxxx	0001 1000 0101 0001	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until Input Word 0 mirrors Output Word 0			
Read counter	0000	xxxx	0000 0000 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgement	Wait until (Input Word 0 & FC00H) mirrors (Output Word 0 & FC00H)			
16-bit count value	Count value = Input Word 1			
Time in ms	Time = count value x resolution: resolution = 2ms			

Technical Data

Safety Devices	
Short-circuit protection	▪ for the sensor power supply: Electronic (automatic restart) ▪ for the switching output: short-circuit protected (automatic restart)

Electrical Isolation	
To provide electrical isolation between the logic level and the I/O it is necessary to supply the I/O Station NIU and the High-speed Counter module using the NIU or a power terminal from separate power supplies. The different 24V supplies must not be connected.	
Common potentials	
24V main voltage (U_M) and 24V segment voltage (U_S) have the same potential (GND). Functional earth ground (FE) is a separate potential area.	
Separate system potentials consisting of NIU/power terminal and I/O terminal	
- Test distance	**- Test Voltage**
5V supply of incoming remote bus / 7.5V supply (bus logic)	500VAC, 50Hz, 1 min.
5V supply of outgoing remote bus / 7.5V supply (bus logic)	500VAC, 50Hz, 1 min.
7.5V supply (bus logic) / 24V supply (I/O)	500VAC, 50Hz, 1 min.
24V supply (I/O) / functional earth ground	500VAC, 50Hz, 1 min.

Noise Immunity		
Surge voltage (Different than other VersaPoint I/O modules)	EN61000-4-5 / IEC 61000-4-5	Criterion B Signal lines 0.5kV (asymmetrical)

Error Messages to the Higher-Level Control or Computer System	
Short circuit / overload of sensor supply	If the sensor supply is short-circuited, the red "Error" LED lights. After a delay of about 1.4 second, the module generates an I/O error message. Also, the diagnostic D LED on the module flashes at medium (24Hz) frequency.

Discrete Inputs			
Number	1 counter input for 24V signals, or 1 counter input for 5V signals 1 control (gate) input for 24V signals, or 1 control (gate) input for 5V signals		
Input resistance	24V inputs: approximately 5.7 k Ohms 5V inputs: approximately 1.7 k Ohms		
Switching thresholds	24V range:	maximum low level voltage: minimum high level voltage:	less than 5V more than 15V
	5V range:	2.5V $\pm$ 1V	
Maximum input voltage	24V inputs: 5V input:	30V 8V	
Common potentials	main supply, ground		
Nominal input voltage	24VDC		
Permissible range	$-0.5V < U_{IN} < 30VDC$		
Nominal inputp current	5mA		
Delay time	less than 5 microseconds		
Input signals	Input signals at the source and gate must be digital		
Switches	Electronic switching preferred. Mechanical contacts can be used in certain applications, through the use of input filtering to compensate for contact bounce.		

Input Characteristic Curve	
Input voltage (V)	Typical input current (mA)
$-0.5V < I_{IN} < 0$	0
3	0.6
6	1.1
9	1.7
12	2.3
15	2.4
18	3.6
21	4.3
24	5.0
27	5.5
30	6.1

Concurrent Channel Derating
None

Switching Output	
Number	1
Nominal output voltage	24VDC
Nominal current	0.5A maximum
Differential voltage for nominal current	less than 1V
Protection	Short circuit, overload
Nominal load: Ohmic Lamp Inductive	 >48Ω / <12W <12W <12VA (>48Ω, <1.2H)
Signal delay ON Ohmic nominal load Lamp nominal load Inductive nominal load	 <50 microsecond typical <25 microsecond typical <1ms typical
Signal delay OFF: Ohmic nominal load Lamp nominal load Inductive nominal load	 <1ms typical <1ms typical <30ms typical
Result of ohmic or lamp overload	Auto-restart after eliminating the overload Note: a bulb characteristic can delay the auto-restart after the overload has been eliminated. This delay can be reduced by briefly switching the output.
Result of inductive overload	Can destroy output
Result of short circuit	Auto-restart after correcting the condition
Limitation of the demagnetization voltage induced on current interruption	Approximately -18V
Overcurrent disconnection	Minimum at 0.7A
Reverse voltage endurance against short pulses	Yes
Maximum revese current	0.5A
Strength against permanently applied surge voltage	No

Output Characteristic when Switched On (typical)	
Output Current (A)	Differential output voltage (V)
0	0
0.1	0.25
0.2	0.35
0.3	0.45
0.4	0.55
0.5	0.65

Concurrent Channel Derating
None

Sensor Supply	
Nominal output voltage	24VDC
Nominal current	0.5A maximum
Differential voltage for nominal current	less than 1V
Protection	Short circuit, overload
Nominal load: Ohmic Lamp Inductive	 48 Ohms minimum, 12W maximum 12W maximum 12VA maximum (48 Ohms minimum / 1.2H maximum)
Result of ohmic or lamp overload	Auto-restart after eliminating the overload Note: a bulb characteristic can delay the auto-restart after the overload has been eliminated. This delay can be reduced by briefly switching the output.
Result of inductive overload	Can destroy output
Result of short circuit	Auto-restart after correcting the condition, I/O error message, typically after delay of 1.4 second. Also, the diagnostic D LED on the module flashes at medium (2Hz) frequency.
Overvoltage disconnection	Minimum at 0.7A
Reverse voltage endurance against short pulses	Yes
Maximum revese current	0.5A
Strength against permanently applied surge voltage	No

Output Characteristic when Switched On (typical)	
Output Current (A)	Differential output voltage (V)
0	0
0.1	0.18
0.2	0.22
0.3	0.27
0.4	0.31
0.5	0.36

Concurrent Channel Derating
None